



## The impact of temperature on the bionomics of *Aedes (Stegomyia) aegypti*, with special reference to the cool geographic range margins

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### Abstract:

The mosquito *Aedes (Stegomyia) aegypti* (L.), which occurs widely in the subtropics and tropics, is the primary urban vector of dengue and yellow fever viruses, and an important vector of chikungunya virus. There is substantial interest in how climate change may impact the bionomics and pathogen transmission potential of this mosquito. This Forum article focuses specifically on the effects of temperature on the bionomics of *Ae. aegypti*, with special emphasis on the cool geographic range margins where future rising temperatures could facilitate population growth. Key aims are to: 1) broadly define intra-annual (seasonal) patterns of occurrence and abundance of *Ae. aegypti*, and their relation to climate conditions; 2) synthesize the existing quantitative knowledge of how temperature impacts the bionomics of different life stages of *Ae. aegypti*; 3) better define the temperature ranges for which existing population dynamics models for *Ae. aegypti* are likely to produce robust predictions; 4) explore potential impacts of climate warming on human risk for exposure to *Ae. aegypti* at its cool range margins; and 5) identify knowledge or data gaps that hinder our ability to predict risk of human exposure to *Ae. aegypti* at the cool margins of its geographic range now and in the future. We first outline basic scenarios for intra-annual occurrence and abundance patterns for *Ae. aegypti*, and then show that these scenarios segregate with regard to climate conditions in selected cities where they occur. We then review how near-constant and intentionally fluctuating temperatures impact development times and survival of eggs and immatures. A subset of data, generated in controlled experimental studies, from the published literature is used to plot development rates and survival of eggs, larvae, and pupae in relation to water temperature. The general shape of the relationship between water temperature and development rate is similar for eggs, larvae, and pupae. Once the lower developmental zero temperature (10-14 degrees C) is exceeded, there is a near-linear relationship up to 30 degrees C. Above this temperature, the development rate is relatively stable or even decreases slightly before falling dramatically near the upper developmental zero temperature, which occurs at -38-42 degrees C. Based on life stage-specific linear relationships between water temperature and development rate in the 15-28 degrees C range, the lower developmental zero temperature is estimated to be 14.0 degrees C for eggs, 11.8 degrees C for larvae, and 10.3 degrees C for pupae. We further conclude that available population dynamics models for *Ae. aegypti*, such as CIMSIM and Skeeter Buster, likely produce robust predictions based on water temperatures in the 16-35 degrees C range, which includes the geographic areas where *Ae. aegypti* and its associated pathogens present the greatest threat to human health, but that they may be less reliable in cool range margins where water temperatures regularly fall below 15 degrees C. Finally, we identify knowledge or data gaps that hinder our ability to predict risk of human exposure to *Ae. aegypti* at the cool margins of its range, now and in the future, based on impacts on mosquito population dynamics of temperature and other important factors, such as water nutrient content, larval density, presence of

biological competitors, and human behavior.

Source: <http://www.ncbi.nlm.nih.gov/pubmed/24897844>

## Resource Description

### Exposure :

weather or climate related pathway by which climate change affects health

Ecosystem Changes, Food/Water Quality, Precipitation, Temperature

**Food/Water Quality:** Other Water Quality Issue

**Water Quality (other):** Water temperature

**Temperature:** Fluctuations

### Geographic Feature:

resource focuses on specific type of geography

General Geographical Feature

### Geographic Location:

resource focuses on specific location

Global or Unspecified

### Health Impact:

specification of health effect or disease related to climate change exposure

Infectious Disease

**Infectious Disease:** Vectorborne Disease

**Vectorborne Disease:** Mosquito-borne Disease

**Mosquito-borne Disease:** Chikungunya, Dengue, Yellow Fever

### Resource Type:

format or standard characteristic of resource

Review

### Timescale:

time period studied

Time Scale Unspecified